ADVANCED PRODUCTION & QUALITY MANAGEMENT

LESSON PLAN

Course Number: **PQM 301**

Module & Title: **Lesson No. 2, Risk Management**

Length (total): **2.5 Hours**

Terminal Learning Objective:

Given an illustrated acquisition program case, evaluate the effectiveness of a risk management process in an Integrated Product and Process Development (IPPD) / Integrated Product Team (IPT) environment.

Enabling Learning Outcomes: The student will be able to:

- Summarize risk management policy in DoD acquisition regulations and how it relates to acquisition reform.
- Outline the risk management process.
- Illustrate examples of risk assessment techniques.
- Identify typical risk areas where risk events may occur, causing deviation from an Acquisition Program Baseline.
- Evaluate the application of a hypothetical Risk Management Process and recommend improvements to the process to mitigate a program's risk within an Integrated Product and Process Development (IPPD) / Integrated Project Team (IPT) environment.

Assignments:
Study: Attached Teaching Note
Study: Chapter 2 of the Risk Management Guide
Study: Case for in-class exercise.

ESPT: 90 minutes

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DEFENSE SYSTEMS MANAGEMENT COLLEGE
PRINCIPLES OF PROGRAM MANAGEMENT DEPARTMENT

Teaching Note

Program Risk Management

W.W. Bahnmaier & Paul McMahon

Program Risk Management Principles - A Summary. The following principles summarize some of the major lessons learned in risk management:

- The primary goals of program risk management are to support the development of an acquisition strategy to meet the user's need with the best balance of cost, schedule, and performance, and to reduce the likelihood of failure by identifying risk events and dealing with them explicitly.

- Poor program planning will exacerbate a program's risk management efforts by establishing unrealistic objectives that do not recognize and account for program risk.

- Risk events must be dealt with in terms of the probability of their occurrence and their impact (severity of consequences) on cost, schedule, and performance.

- High, low, and moderate risk should also be defined in terms of probability of occurrence and cost, schedule, and performance impact (severity of consequences).

- Risk should be assessed within the context of an acquisition strategy. Change the acquisition strategy and you change the risk.

- Unless the original plan was sub-optimal, risk reduction will almost always involve trading off cost, schedule, and performance.

- Risk is defined in terms of Cost, Schedule, and Performance (Technical) Risk. Under the "Cost as an Independent Variable" (CAIV) concept, as cost-performance tradeoffs (including risk) are made on an iterative basis, aggressive cost goals are established that become more of a constraint, and less of a variable. Therefore, the PM may be required to trade performance/technical and schedule - and their risks - to meet CAIV cost constraints and reduce cost risk.

- Risk can never be fully eliminated or completely transferred. We are not able to buy down all program risk; therefore, risk must be prioritized for handling based upon assessment. **Attachment 1** provides a rule-based approach to doing risk assessment and prioritization. This is a commercial model used by the Carrier Corporation.

- The principal purpose of research and development is to reduce the uncertainty, and thereby the risk, associated with acquiring a new system. In this regard, risk can be considered "good" in that acceptance of some risk opens up "opportunities" for technological breakthroughs.

- There are products throughout the Risk Management Process that need to be developed and captured as documentation (digital preferred) for monitoring and reporting of the process. Documentation products are shown in **Attachment 2**.

- Commercial and Government computer software models have been developed to help us better plan and perform risk management. A summary of some models used in the Department of Defense is briefly described in **attachment 3**.

"Rule Based" Risk Assessment*

1. **Project Name:**

2. **Model(s)/Component(s):**

3. **Definitions:**

Levels	Ratings
High Probability and High Consequence of Occurrence	High
Low Probability and High Consequence of Occurrence	Medium - High
High Probability and Low Consequence of Occurrence	Medium
Low Probability and Low Consequence of Occurrence	Low

4. **Assessment Guidelines:**

High Probability: The probability of problems is high if the element has:
- a history of problems in other applications, or...
- questionable capability/reliability test data, or...
- unknown capability/reliability data or tests, or...
- application near or past tested duty limits, or...
- untested duty limits, or...
- New, novel, or unique application duties

Low Probability: The probability of problems occurring is low if:
- No high-probability conditions exist, or...
- Clear actions have been taken to minimize or eliminate inadequate performance/reliability, and to reliably monitor or qualify performance status.

High Impact: Risks have high impact if failures could:
- Exceed factory or improvement goals for field failure rates (FFRs), Warranty, or Rework
- Limit the support or services of distributors, dealers, installers or repairers.
- Subject customers/users to major inconvenience, chronic annoyance, or significant costs.
- Cause unacceptable project delays or target-margin variances (market price, mfg. cost, or target volume).

Low Impact: Risks have low impact if:
- No high impact conditions exist, or...
- Clear and effective plans are in place to minimize negative consequences and correct root causes

Attachment 1-1

5. Overall Ratings: HIGH risks have High Probability and High Consequence/Impact

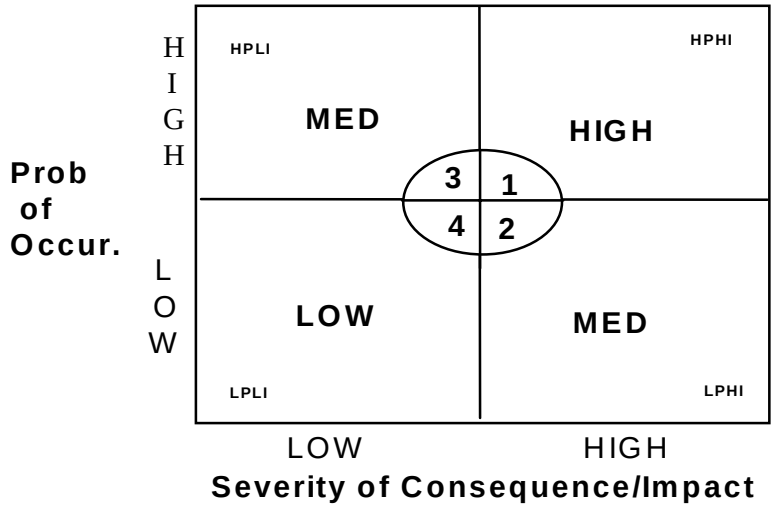
MEDIUM risks have High Probability but Low Consequence, or Low Probability but High Consequence

LOW risks have Low Probability and Low Impact

6. Systems Requiring Risk Assessment: Any system, product, process, support element or sub-system thereof which is key to a system's deployment and employment success, but uncertain as to its functional capability, quality, reliability, availability, or conformance to requirements. Typically, risk events for these systems impact on or have consequences for program costs and schedule, and on product performance.

7. Risk Classifications/Ratings for risk events:

Risk Classification/Ratings



Note: Blocks 1,2,3 are logical priorities for risk reduction and management attention.

Attachment 1-2

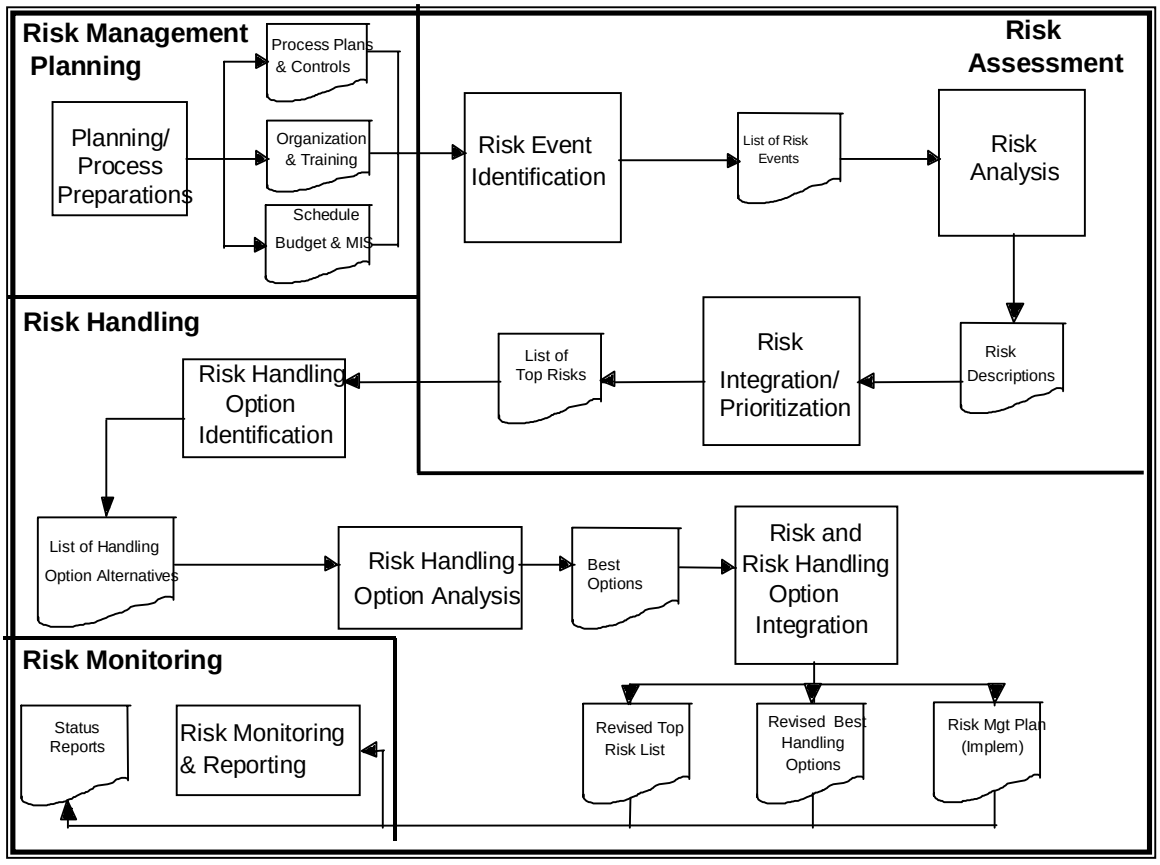
8. <u>Assessment Table</u>: (An example)

*	Risk Event Description	Impacts On	Team Resp. - Risk Level				Overall Risk Rating
			HP	HI	LP	LI	
1	Proposed Generator has high diode failures on existing Generator applications (reliability)	Schedule (Testing) & Product Cost	X	X			High
2	Single Source (Kubota) for diesel engines (sourcing)	JIT Assembly Process Schedule Reliability		X	X		Med
3	Unit Frame is too large & heavy for the powder-painting process conveyer (manufacturing)	Product Cost & Quality Control Requirements	X			X	Med
4	Unclear if User Requirement for 120 U.S. Gal Fuel tank is to meet run-time needs or competitor's spec's (design)	Testing & Marketing Emphasis			X	X	Low
	ETC.						

*Carrier Corporation calls this risk assessment methodology “rule based” because it provides a set of rules or guidelines to help determine risk levels.

Attachment 1-3

Risk Management Process Model



Attachment 2

SOME EXAMPLES OF COMMONLY USED RISK SOFTWARE

(Additional information on the risk management software packages described herein can be obtained from the Principles of Program Management and Leadership Dept., DSMC)

RISKNAV*

A MANAGEMENT TOOL FOR PRIORITIZING, DISPLAYING, AND TRACKING PROGRAM RISK

Prepared for: The MITRE Corporation, beta release version .5, October 1995

Prepared by: The MITRE Corporation, Economics and Analysis Center, 202 Burlington Road, Bedford, Ma. 01730

POC: P. R. Garvey, (781) 271-6002; e-mail: pgarvey@mitre.org

RiskNAV is a management tool that aids in identifying where engineering assets are best applied to mitigate potentially crippling areas of risk to a program. The purpose is to provide program offices a structure for conducting continuous risk assessments. It was designed to provide a straightforward way to isolate key critical risk events from those considered less threatening. It is an application of Multi-attribute Utility Theory to prioritize project risk.

* In the Air Force, RiskNAV also known as Risk "TRAP" - Technical Risk Assessment Program

RISK MATRIX

A STRUCTURE FOR IDENTIFYING AND PRIORITIZING PROGRAM RISKS.

Prepared for: U.S.A.F.

Prepared by: Department of the Air Force, Headquarters ESC (AFMC), Hanscom AFB, MA, 01731-5000

POC: P. R. Garvey, MITRE, (781) 271-6002; e-mail: pgarvey@mitre.org

Risk Matrix was developed by the Electronic Systems Center (ESC) to provide a structure for identifying and prioritizing program risks. It facilitates the thought process of identifying risks and provides a structured way to prioritize, evaluate, document, and manage the impact of key risks on projects.

ANALYTIC COST PROBABILITY MODEL (ACOP)

PRESENTS THE FOUNDATIONS OF A RECENTLY DEVELOPED ANALYTIC APPROACH TO SYSTEM COST UNCERTAINTY ANALYSIS.

Prepared for: Publication in "Cost Analysis in Transition - Shifting US Priorities," SPRINGER - VERLAG, NEW YORK, June 1991

Prepared by: The MITRE Corporation POC: P. R. Garvey, (781) 271-6002. Economics and Analysis Center, 202 Burlington Road, Bedford, Ma. 01730

This paper presents the foundations of recently developed analytic approach to system cost uncertainty analysis. The approach is referred to as the Analytic Cost Probability (ACOP) model; and its structure is sufficiently general to meet the characteristics of any program definition.

Attachment 3 – 1

ANALYTIC SOFTWARE EFFORT PROBABILITY (ASEP) MODEL

PRESENTS THREE METHODS WHICH QUANTIFY THE EFFECTS OF UNCERTAINTY IN SOFTWARE DEVELOPMENT EFFORT

Prepared for: The MITRE Corporation

Prepared by: The MITRE Technical Report MTR 10212; Garvey, Paul, R., May 1987, POC: Paul R. Garvey, (781) 271-6002

Software development effort estimates have several major sources of uncertainty. Among these uncertainties are the size of the project, the development attribute ratings, and the error of the estimation model. This paper presents three methods that quantify the effects of these uncertainties on development effort estimates.

BIVARIATE COST-SCHEDULE PROBABILITY MODELS

PRESENTS AN APPLICATION OF BIVARIATE PROBABILITY THEORY

Prepared for/by : The MITRE Corporation, Journal Publication Source MORS, July 1996, POC: Paul R. Garvey, (781) 271-6002

This is a paper that presents an application of BIVARIATE probability theory to modeling cost and schedule uncertainties. It has long been recognized that program cost and schedule estimates are correlated; however, formal methods have not been developed in the cost analysis community to study their joint behavior, To address this, BIVARIATE models for approximating the joint and conditional probabilities of program cost and schedule estimates are presented. Specifically, the BIVARIATE lognormal and BIVARIATE normal-lognormal models are discussed. The statistical properties of these models are provided. A cost analysis application is presented to illustrate their use in a practical context. Methodology described can be programmed in an Excel spreadsheet.

STAGE-WISE REGRESSION MODEL

A SYSTEMATIC APPROACH FOR CONSTRUCTING A TOTAL COST EQUATION USING THE STAGE-WISE REGRESSION PROCEDURE.

Prepared for: The MITRE Corporation

Prepared by: Chien Ching Cho, Leah M. Gaffney, The Journal of Cost Analysis, fall 1996, (781) 271-6287

A frequently used methodology in cost estimating is the use of linear cost estimating relationships between prime mission product (PMP) and non-PMP costs such as test and program management. When assessing the uncertainty associated with such an estimate, it is often improperly assumed that the cost components are either totally independent or perfectly correlated. These simplifying assumptions could lead to a large error in the construction of the total cost distribution, thus significantly impacting the ensuing risk assessment. This paper presents a systematic approach for constructing a total cost equation using the stage-wise regression procedure.

Attachment 3 – 2

C-RISK - COST RISK

PRODUCES AND JUSTIFIES COST - PROBABILITY DISTRIBUTIONS OF WBS ELEMENTS AND CORRELATION BETWEEN THEIR RISK-RELATED BOUNDS.

Prepared for: The Air Force Space and Missile Center (AFMC/SMC) and the Aerospace Corporation. Version 3.0, 1994

Prepared by: The Aerospace Corporation. Mail Station MM4-021, PO Box 92957 Los Angeles, CA 90009-2957, POC: Stephen A. Book, (310) 336-8655

The Air Force Space and Missile Systems Center (AFMC/SMC) and the Aerospace Corporation originally developed C-RISK for in-house use. It is now available upon request to all U.S. Government Agencies and their contractors. Its objective is to produce and justify cost-probability distributions of individual work-breakdown-structure (WBS) elements and correlation between their risk-related bounds. The resulting distributions and correlation can then be input into FRISK, Crystal Ball, @Risk, or other commercially available software to compute the probability distribution of total cost.

TRL-RISK-TECHNOLOGY-READINESS-LEVEL-BASED RISK ANALYSIS

A COST-RISK ANALYSIS PROCEDURE

Prepared for: NASA, Version 1.0, February 1996

Prepared by: The Aerospace Corp. Hallmark Building 13873 Park Center Road Herndon, VA 22071, POC: Erik L. Burgess, (703) 318-2477

TRL-RISK is a cost-risk analysis procedure for using NASA's "Technology Readiness Level" (TRL) as a useful metric for expressing technology/design maturity. The TRL serves as a quantitative input into the cost-risk analysis process. It has been implemented as part of the Small-Satellite Cost-Engineering Model (SSCEM) under development for NASA's Jet Propulsion Laboratory (JPL).

METHODS AND METRICS FOR PRODUCT SUCCESS

A GUIDE TO TECHNICAL METHODS AND METRICS WHICH HAVE PROVEN SUCCESSFUL IN PRODUCT DEVELOPMENT.

Produced for: Assistant Secretary of the Navy (Research, Development and Acquisition)

Produced by: Willis J. Willougby Jr., Office of the Assistant Secretary of the Navy (Research, Development and Acquisition) 2000 Navy Pentagon, Washington D.C. 20350, POC: D. Porter (703) 602-5506

Produced in July 1994, the book is an attempt to guide government and industry toward an understanding of those technical methods and metrics, which have been proved over time to ensure an successful product. The focus is in the technical process that will supplant milspecs as the basis for military acquisition. Use of proven best practices and the management of the technical process comprising design, test, and production discipline are combined in the belief that management of these process will reduce many other types of risk.

COST-RISK IDENTIFICATION AND MANAGEMENT SYSTEM (CRIMS)

PROVIDES A MEANS TO IDENTIFY THE COST IMPACTS ON PROGRAM DUE TO RISK.

Prepared for: The Air Force Material Command Space and Missile Systems Center.
Prepared by: Space and Missile Systems Center, Financial Management and Comptroller 2430 E. El Segundo Blvd. Suite 2010, El Segundo, Ca, 90245-4687
POC: D. R. Graham (SMC/FMC) and J. Dechoretz (MCR) (310) 363-0131

CRIMS was developed as a means to identify the cost impacts on a program due to risk. Its use enables analysts to quantify the impact of technical and schedule uncertainty, positively differentiate between the different drivers of acquisition cost change, and to track risk driven cost change to better predict future outcomes.

FRISK - FORMAL RISK ASSESSMENT OF SYSTEMS COST ESTIMATES

PROVIDES A MEANS FOR QUICK RESPONSE TRADE STUDIES.

Prepared for: Air Force Space and Missile Center (AFMC/SMC)
Prepared by: The Aerospace Corporation., PO Box 92957 Los Angeles, CA 9009-2957, Version 3.2, Sep 1992
POC: Stephen A. Book, (310) 336-8655

Cost estimates are typically derived by determining low, best estimate, and high cost for each of several cost elements in a Work Breakdown Structure (WBS) as a result of technical risk assessment after which a statistical distribution, such as a triangular, is postulated for each element cost. Means, variances, and typical percentiles can be derived from the statistical distribution. Dependencies among cost elements can be quantified in terms of a correlation matrix. Then the distribution of the sum of the element cost is determined, typically by a Monte Carlo sampling technique.

CRYSTAL BALL 4.0

A MANAGEMENT TOOL FOR FORECASTING AND RISK ANALYSIS

Prepared for: Commercial sale
Prepared by: Decisioneering, Inc. 1515 Arapaho Street, Suite 1311, Denver, Colorado, USA 80202, POC: Decisioneering, Inc. Telephone: (303) 534-1515, Facsimile: (303) 534-4818, and Internet: www.decisioneering.com

Crystal Ball is a risk analysis tool that uses Monte Carlo simulation to forecast potential outcomes for a program when uncertainty exists for multiple elements of the program. Crystal Ball acts as a spreadsheet add-in that requires either Microsoft Excel 4.0 (or later) or Lotus 1-2-3 Release 4 (or later). Data are entered as a spreadsheet(s) and then analyzed by the add-in module.

OPEN PLAN PROFESSIONAL™, OPEN PLAN DESKTOP™, AND OPERA

MANAGEMENT TOOLS FOR PROJECT MANAGEMENT

Prepared by: Welcom Software Technology: WST Corporation, 15995 North Barkers Landing, Suite 275, Houston, Texas 77079-2494

POC: Diana M. Melton, (713) 558-0514; e-mail dmelton@wst.com

The Welcom Program Management software package includes Open Plan Professional, a program that uses embedded tools to integrate project management functions across an organization, Open Plan Desktop, which may be used to schedule projects, manage resource requirements, perform "what if" analyses, report earned value, and use corporate wide databases, and Opera, an Open Plan extension for risk analysis.

IPD TOOLKIT

A COLLECTION OF PROCESSES AND SOFTWARE TOOLS THAT PROVIDE INTEGRATED COST, SCHEDULE AND RISK PERFORMANCE MEASUREMENT

Prepared for: Commercial sale

Prepared by: C/S Solutions, Inc. 1324-J State Street # 174, Santa Barbara CA, 93101-1024, POC: C/S Solutions, Inc. Telephone: (805) 653-4951 Facsimile: (805) 563-4961 Internet: www.cs-solutions.com

The IPD tool kit is designed as an aid for the Integrated Product Development Team (IPD) Members. It integrates and customizes off-the-shelf software including MS Project, MS mail, wInsight, C/S glue and Risk +. The IPD tool kit currently supports Windows 3.1, 95. NT and Macintosh.

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